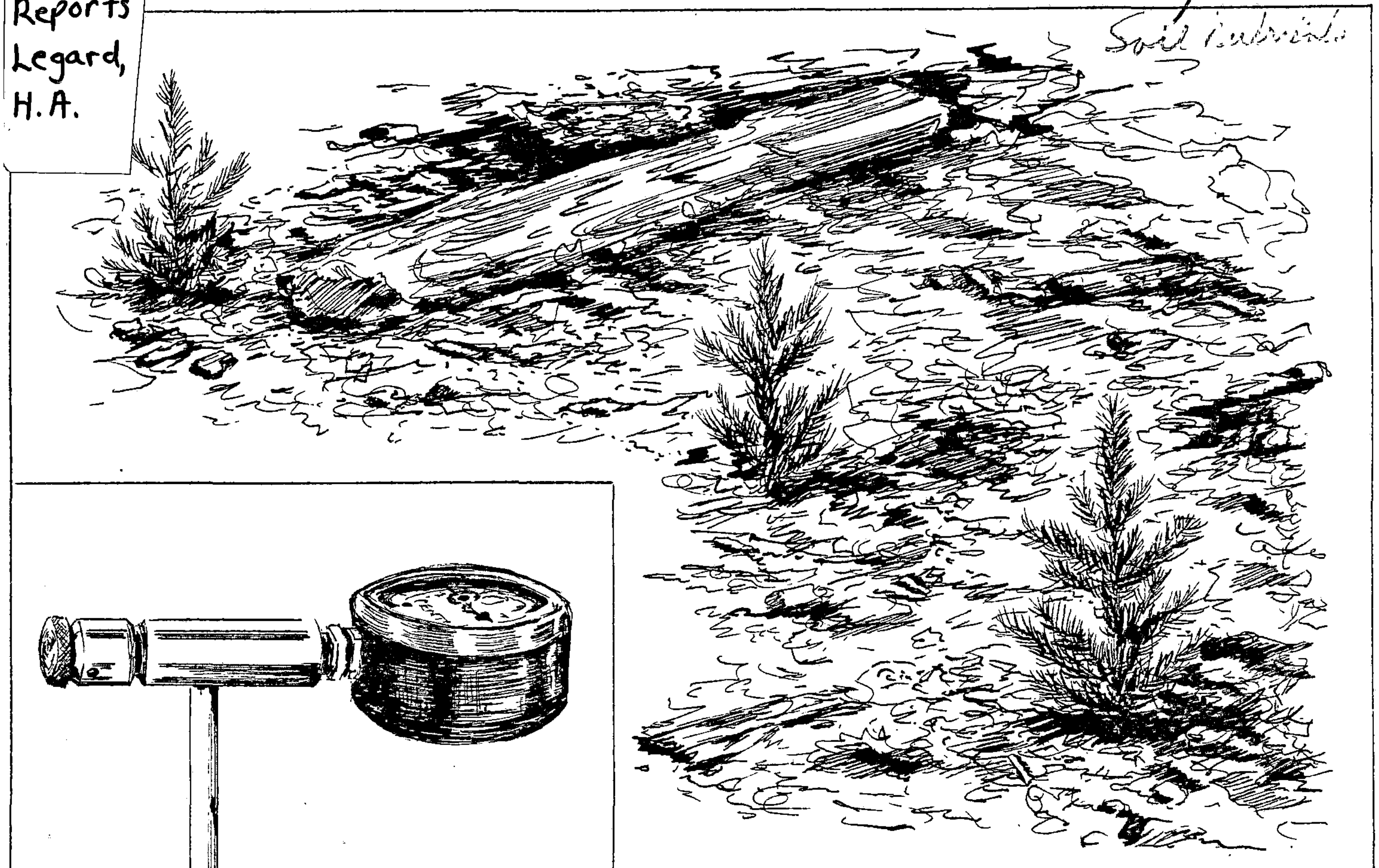

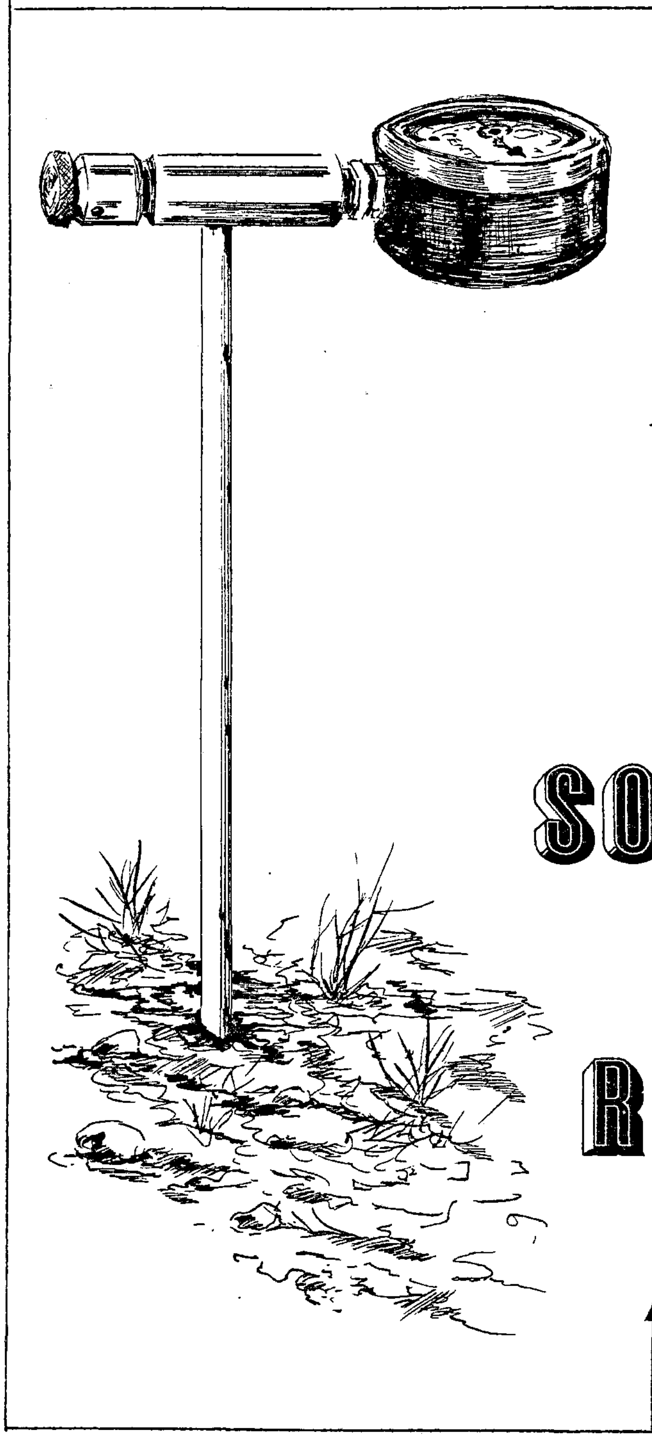

PREDICTING SOIL MOISTURE FOR REFORESTATION NEEDS

PREDICTING SOIL MOISTURE

FOR

REFORESTATION NEEDS

by

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T A B L E   O F   C O N T E N T S

PREDICTING SOIL MOISTURE FOR REFORESTATION NEEDS

INTRODUCTION

Adequate soil moisture, at the time of planting and for a period of time afterwards, is essential for successful reforestation. This assumes that a healthy, viable, well-adapted seedling has been correctly planted on the site. Chapter 61.11 of FSH 2409.26b R-6 states, ". . . soil on the planting site must be damp. It should feel damp, in the hand, down below the maximum depth tree roots will be planted. . . ." This implies that the soil moisture content will be "at" or "near" field capacity at the time of planting.

Outlined below is a method utilizing computer programs, laboratory soil moisture determinations at various moisture tensions, and actual field moisture measurements by which the user can estimate, in advance of planting, the times of optimum soil moisture and the length of time soil moisture will be satisfactory for planting. Using actual field soil moisture measurements, planting can then be scheduled to improve the likelihood that optimum soil moisture conditions will occur during and after planting at various locations.

SOIL MOISTURE ASSUMPTIONS

In order for this method of estimating soil moisture for reforestation needs to work in the field, several assumptions had to be made.

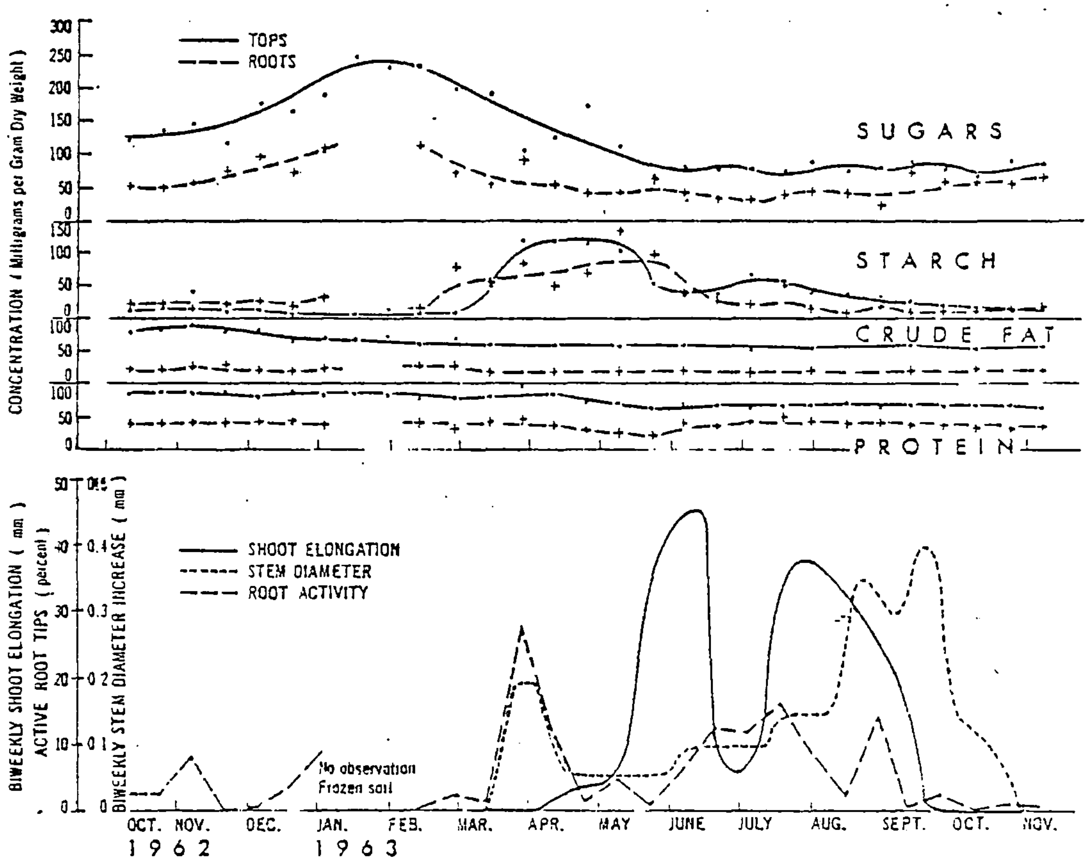
1. Available Soil Moisture - Must Have Four Weeks

   For plants to adjust after planting, they must have four weeks of available soil moisture. This assumption is based on research conducted by Krueger and Trappe at the Wind River Nursery on Willamette National Forest stock.1/ They found that rapid root growth preceded and followed rapid shoot elongation. (See FIGURE 1, page 3.)

   From their graph of "Root Activity, Diameter and Shoot Elongation," it was estimated that the first surge of root growth lasted about four weeks. It was assumed therefore that, if soil moisture became limiting during this four-week surge of root growth and establishment, the plant would be severely stressed.

1/ Kruger, Kenneth W., and J. M. Trappe, 1967. Food Reserves and Seasonal Growth of Douglas-fir Seedlings. Forest Science, Volume 13, No. 2, June 1967.

FIGURE 1 - Seasonal trends in food reserves, root activity, and rate of diameter and shoot growth as revealed by biweekly sampling of Douglas-fir seedlings of Willamette source.



2. Critical Zone - Top 10 Inches of Soil

This is the zone where the roots of the planted trees are located and is therefore the "Critical Moisture Zone." Tensiometer readings should be made at the expected planting depth within this zone.

3. Monthly Potential Evapo-Transpiration (PET) - Uniform Over the Time Span Used

Since it is impossible to predict cloud cover and other factors that influence potential evapo-transpiration rates, it must be assumed that potential evapo-transpiration rates will be uniform over selected periods of time.

4. Field Capacity (0.1 - 0.6 Atmos.)

Planting "at" or "near" field capacity provides the plant with a maximum amount of readily available moisture during establishment. Planting at higher moisture tensions (drier soil conditions) places the plant under greater stress.

5. Wilting Point (15 Atmos.)

At this moisture tension, soil moisture is in short supply and the plant is in a very stressed condition.

6. Survival

If a seedling is planted "at" or "near" field capacity and has four weeks of moisture to adjust, it will survive.

These assumptions are fundamental to the program and must be thoroughly understood.

HOW THE SYSTEM WORKS

Site-specific data such as latitude, slope, aspect, elevation, and average monthly precipitation and temperature are fed into the REGIME 3-Soil Moisture Regime Program at the Fort Collins Computer Center. This computer program computes the monthly potential evapo-transpiration and soil moisture regime for a specific site. (See FIGURE 2, page 6.)

This information is then graphed on yearly graph paper by the user and the daily loss of water (rate of depletion) due to evapo-transpiration for each month is calculated and indicated on the graph (See FIGURE 3, page 7.) This graph shows the changes in soil moisture status based on past climatic records for that site.

On-site field moisture measurements are then made using a soil tensiometer, and these readings are converted to "inches of available water." This "available water" is entered on the user-constructed graph of the computer

FIGURE 2 - REGIME 3 - Soil Moisture Regime Program showing monthly temperature, precipitation, Potential Evapo-Transpiration (PET), Actual Evapo-Transpiration (AET), and moisture status for a specific site.

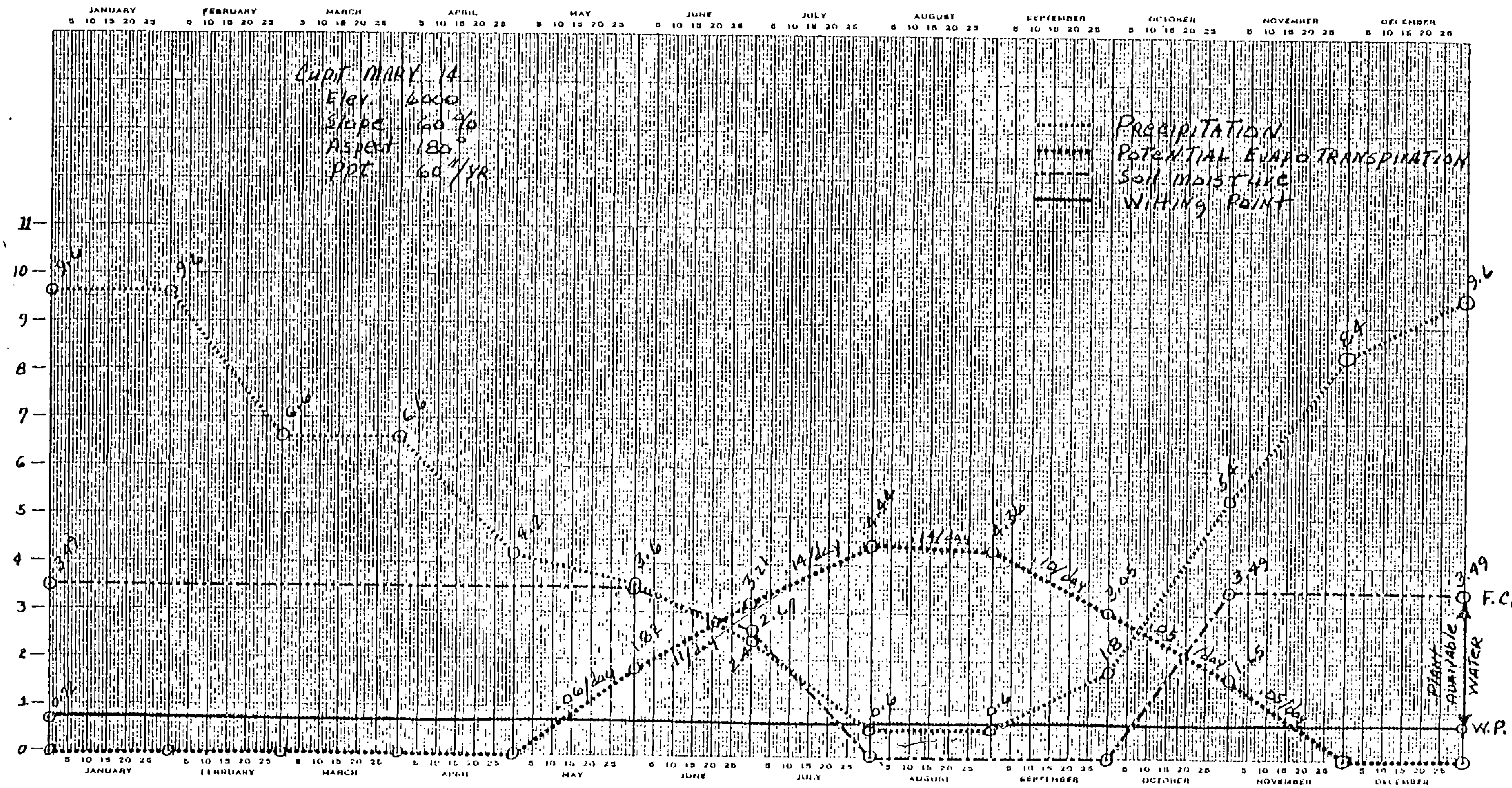
```
* * * * * SOIL MOISTURE VALUES ARE IN INCHES * * * * * * *
HORIZON    THICKNESS  ROCK     FIELD     WILTING   PLANT AVAIL-
NAME         (IN)      ()     CAPACITY    POINT     ABLE WATER

A1            10.       0       3.49       .72         2.77

TOTAL *       10.               3.49       .72         2.77

*     *     *     *     *     *     *     *     *     *     *
```

```
*     *     *     *     *     *     *     *     *     *     *     *

                    SOIL MOISTURE REGIME

93

ELEVATION =  6000. FEET
LATITUDE =  43. DEG.  43. MIN.     SLOPE =  60.%    ASPECT = 180. DEG
MEAN ANNUAL AIR TEMP = 36.71   MEAN ANNUAL SOIL TEMP = 40.39
CLIMATIC DATA FROM
CUPIT MARY 14
F.C. =   3.49 IN.     W.P. =    .72 IN.     P.A.W. =   2.77 IN.
```

MO.	TEMP (F)	PRECIP (IN)	PET (IN)	AET (IN)	* * * * MOISTURE * * * * SOIL (IN)	CHARGE (IN)	SURPLUS (IN)	DEFICIT (IN)
JAN	23.8	9.60	.00	.00	3.49	.00	9.60	.00
FEB	26.1	6.60	.00	.00	3.49	.00	6.60	.00
MAR	27.2	6.60	.00	.00	3.49	.00	6.60	.00
APR	28.9	4.20	.00	.00	3.49	.00	4.20	.00
MAY	38.8	3.60	1.82	1.82	3.49	.00	1.78	.00
JUN	47.5	2.40	3.21	3.21	2.67	.00	.00	.00
JUL	55.2	.60	4.44	3.27	.00	.00	.00	1.16
AUG	54.7	.60	4.36	.60	.00	.00	.00	3.76
SEP	46.3	1.80	3.05	1.80	.00	.00	.00	1.25
OCT	37.6	5.40	1.65	1.65	3.49	3.49	.27	.00
NOV	30.3	8.40	.00	.00	3.49	.00	8.40	.00
DEC	24.1	9.60	.00	.00	3.49	.00	9.60	.00
TOTAL		59.40	18.53	12.36		3.49	47.04	6.1

```
*     *     *     *     *     *     *     *     *     *     *     *
```

FIGURE 3 - User-constructed graph showing monthly precipitation, monthly potential evapotranspiration and daily depletion rate, and soil moisture status.



printout for the date the reading was taken. The amount of "available water" is then compared to the indicated "rate of depletion" and a determination is made as to whether or not 28 days of moisture exists in the soil; or, if not, can precipitation be expected to make up the difference.

Since the computer printout information is based on past climatic records and no two years are exactly alike, a graph of weekly precipitation should be kept and compared to the past record. In this way, it can easily be determined if this season is average, or wetter or drier than average, and is invaluable when considering the chances for extra moisture through precipitation.

DATA REQUIREMENTS

In order for this program to work, certain site-specific data is required. The following is a discussion and listing of all specific data required for a particular site.

Climate

There are 21 climatic stations on or near the Willamette National Forest with up to 41 years of continuous weather records at several stations. (See FIGURE 4, page 9.) Precipitation and temperature are the most important of all the weather records kept. One must be able to calculate

FIGURE 4

CLIMATIC DATA 1/
WILLAMETTE NATIONAL FOREST AND ADJACENT AREAS
AVERAGE MEAN MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION

	STATION	ELEVATION	PERIOD	JANUARY (1)	JANUARY (2)	FEBRUARY (1)	FEBRUARY (2)	MARCH (1)	MARCH (2)	APRIL (1)	APRIL (2)	MAY (1)	MAY (2)	JUNE (1)	JUNE (2)	JULY (1)	JULY (2)	AUGUST (1)	AUGUST (2)	SEPTEMBER (1)	SEPTEMBER (2)	OCTOBER (1)	OCTOBER (2)	NOVEMBER (1)	NOVEMBER (2)	DECEMBER (1)	DECEMBER (2)	NORMAL MEAN AVERAGE	
1.	Belknap Springs Sec. 11, T. 16 S., R. 6 E.	2152'	1961-72	32.4	13.71	37.0	8.57	38.9	7.51	43.8	4.82	51.4	3.41	59.1	1.96	64.6	0.52	64.8	1.01	58.1	2.83	48.7	6.53	40.9	11.67	33.2	13.51	47.8	76.05
2.	Cascadia State Park Sec. 32, T. 13 S., R. 3 E.	850'	1931-72	37.0	8.88	41.0	6.66	43.5	7.04	48.1	4.96	53.5	3.84	59.6	2.91	64.2	0.58	64.4	0.93	59.3	2.31	50.4	5.67	43.6	8.24	38.9	9.38	50.3	61.40
	Cougar Dam Sec. 32, T. 16 S., R.5 E.	1262'	1960-72	-	15.09	-	11.05	-	9.78	-	6.70	-	4.25	-	2.08	-	0.49	-	1.38	-	2.93	-	4.89	-	11.79	-	13.64	-	84.07
3.	Detroit Dam Sec. 7, T.10 S., R.5 E.	1300'	1954-72	37.4	14.16	41.7	9.50	43.0	9.91	46.5	6.77	53.7	4.47	60.4	2.89	66.1	0.63	66.8	1.40	61.0	3.56	52.6	7.53	44.1	12.85	38.5	14.19	50.9	87.86
4.	Detroit, Oregon Sec. 1, T.10 S., R.5 E.	1586'	1931-72	33.7	12.26	37.7	9.21	40.6	8.78	46.6	5.38	53.0	3.72	58.3	2.63	64.0	0.56	63.3	1.04	58.5	2.79	50.3	7.18	41.3	11.58	36.3	13.37	48.6	78.50
5.	Eugene, Oregon	359'	1931-72	40.1	7.22	43.2	4.84	45.8	4.56	50.1	2.57	56.3	2.11	57.9	1.43	66.3	0.27	66.0	0.59	60.9	1.44	53.2	3.83	45.9	5.81	40.9	7.38	52.2	42.05
6.	Foster, Oregon Sec. 27, T.13 S., R.1 E.	720'	1963-72	40.5	11.54	43.5	5.60	45.8	6.27	47.7	5.81	54.4	2.81	59.6	1.98	65.7	0.07	65.6	0.34	58.4	2.31	53.5	3.15	45.9	5.18	40.3	9.55	51.7	54.61
	Hills Crk. Dam Sec. 35, T. 21 S., R. 3 E.	1275'	1960-72	-	6.94	-	4.13	-	4.51	-	3.30	-	2.80	-	1.81	-	0.19	-	0.51	-	1.57	-	3.42	-	6.51	-	7.11	-	42.80
7.	Leaburg Dam Sec. 31, T.16 S., R. 2 E.	675'	1933-72	39.8	8.92	43.4	7.12	46.0	6.78	51.0	4.53	56.5	3.44	61.5	2.83	66.9	0.60	66.4	0.86	62.3	2.28	53.8	5.71	45.7	8.73	41.2	9.63	52.9	61.43
8.	Lookout Point Dam Sec. 13, T. 19 S., R. 1 W.	712'	1955-72	40.8	7.55	45.0	4.80	46.6	5.00	49.4	3.34	55.2	3.28	61.4	2.07	66.7	0.36	67.2	0.78	62.0	1.76	55.4	3.68	47.4	6.17	41.9	6.99	53.2	45.78
	Lowell 1-E Sec. 15, T. 19 S., R. 1 W.	1010'	1946-55	-	6.58	-	4.36	-	4.80	-	2.87	-	2.53	-	2.57	-	0.38	-	0.78	-	1.35	-	5.16	-	5.67	-	7.77	-	44.82
	Lowell 2-N Sec. 15, T. 19 S., R. 1 W.	740'	1951-59	-	7.08	-	5.48	-	4.89	-	2.95	-	3.22	-	2.86	-	0.23	-	0.74	-	1.10	-	4.55	-	4.88	-	8.28	-	46.26
9.	Marion Fks. Fish Hatchery Sec. 15, T. 11 S., R. 7 E.	2425'	1951-72	31.2	12.03	34.8	7.53	37.0	8.36	42.6	4.60	50.7	3.31	57.6	2.08	63.5	0.58	62.0	1.17	55.5	2.42	46.9	5.92	37.8	10.13	32.8	10.71	46.0	68.84
10.	McCredie Springs Sec. 36, T. 31 S., R. 4 E.	2121'	1944-50	33.0	7.04	36.5	6.47	40.8	5.73	48.2	3.48	54.1	3.44	58.5	2.76	63.9	0.95	64.0	0.51	58.4	2.06	48.0	4.27	39.0	7.47	34.7	5.99	48.3	50.17
11.	McKenzie Ranger Station Sec. 18, T. 16 S., R. 6 E.	1375'	1931-72	35.2	11.27	39.8	8.04	42.9	7.99	48.4	4.69	54.6	3.72	60.2	2.79	65.7	0.51	64.5	0.83	59.5	2.46	51.8	6.37	42.6	9.77	36.8	11.61	50.2	70.05
12.	Oakridge Ranger Station Sec. 11, T. 21 S., R. 2 E.	1310'	1931-52	38.1	6.40	41.6	4.91	46.7	4.91	52.2	3.17	57.6	2.42	62.0	2.08	68.0	0.47	68.0	0.45	63.9	1.32	55.3	3.98	45.2	5.88	40.3	6.33	53.2	42.32
13.	Oakridge Salmon Hatchery Sec. 15, T. 21 S., R. 3 E.	1275'	1951-72	37.5	7.87	42.4	4.75	45.4	5.08	49.9	3.06	55.8	3.03	61.6	1.86	67.2	0.31	67.2	0.69	62.1	1.40	53.5	3.67	44.9	6.32	39.1	7.73	52.2	45.77
	Quartzville Sec. 29, T. 11 S., R. 4 E.	823'	1951-60	-	14.76	-	10.54	-	11.18	-	6.28	-	5.05	-	3.24	-	0.58	-	1.31	-	3.07	-	8.58	-	11.30	-	15.55	-	91.44
	Santiam Junction Sec. 14, T. 13 S., R. 7 E.	3990'	1953-65	-	9.71	-	8.44	-	9.28	-	6.00	-	4.32	-	2.50	-	0.62	-	1.36	-	2.44	-	4.77	-	10.69	-	10.84	-	70.97
14.	Santiam Pass Sec. 24, T. 13 S., R. 7½ E.	4748'	1963-72	27.4	19.77	30.4	6.63	32.0	9.34	34.5	5.98	43.3	3.49	51.2	3.07	58.4	0.91	58.0	1.47	50.5	3.60	41.8	6.56	34.2	12.05	28.1	16.00	40.8	88.87
	West Fir, Oregon Sec. 7, T. 21 S., R. 3 E.	1070'	1940-64	-	6.80	-	5.87	-	5.38	-	3.87	-	3.48	-	1.97	-	0.54	-	0.56	-	1.72	-	4.16	-	6.70	-	7.50	-	48.55

1/ Data compiled from the following sources: Weather Bureau, U.S. Dept. of Commerce; Eugene Water & Electric Board; U.S. Army Corps of Engineers.
The above values are summations of various sources of data and may vary slightly from other reported information.

(1) Mean Temperature

(2) Mean Precipitation

the average monthly precipitation and average monthly temperature for any given planting site. Several methods exist to accomplish this.

Average Monthly Precipitation - The average percent precipitation by month was determined for each recording station and these values were compared, month by month. The comparison revealed that, for any given month, the percent of the total precipitation remained remarkably similar, even though the total precipitation varied significantly; i.e., Eugene, Oregon receives an average of 42.05 inches of precipitation, of which 17 percent occurs during January; while Detroit, Oregon receives an average of 78.50 inches of precipitation, of which 16 percent occurs during January. (See FIGURE 5, page 11.)

By using this method, one only needs to consult an isohyetal map (See FIGURE 6, page 12), determine the approximate annual precipitation for the site in question, and divide this amount by the percent received each month. Extreme accuracy is not required, as this program requires only average monthly precipitation amounts. (*Example 1*, page 13, illustrates the process.)

Average Monthly Temperature - Determining average monthly temperatures for a specific site is a rather simple but tedious job. Basically, two recording stations are selected that are in close proximity to the desired site and are located at elevations both above and below the site, if possible. The difference in elevation

FIGURE 5

PERCENT PPT. BY MONTH

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	PPT
Belknap Sp.	18	11	10	6	4	3	1	1	4	9	15	18	76.05"
Cascadia St. Pk.	14	11	12	8	6	5	1	2	4	9	13	15	61.40"
Cougar Dam	18	13	12	8	5	2	1	2	3	6	14	16	84.07"
Detroit Dam	16	11	11	8	5	3	1	1	4	9	15	16	87.86"
Detroit, OR	16	12	11	7	5	3	1	1	3	9	15	17	78.50"
Eugene, OR	17	12	11	6	5	3	1	1	3	9	14	18	42.05"
Foster, OR	21	10	11	11	5	4	1	1	4	6	9	17	54.61"
Hills Crk Dam	16	10	11	8	6	4	0	1	4	8	15	17	42.80"
Leaburg Dam	16	11	11	7	5	5	1	1	4	9	14	16	61.43"
Lookout Pt. Dam	16	11	11	7	7	5	1	2	4	8	13	15	45.78"
Lowell 1-E	15	11	11	6	6	6	1	2	3	11	13	17	44.82"
Lowell 2-N	15	12	11	6	7	6	1	1	2	10	11	18	46.26"
Marion Fks F.H.	17	11	12	7	5	3	1	2	3	9	15	15	68.84"
McCredie Spr.	14	13	11	7	7	5	2	1	4	9	15	12	50.17"
McKenzie Rgr. St.	16	11	11	7	5	4	1	1	4	9	14	17	70.05"
Oakridge Rgr. St.	15	12	12	7	6	5	1	1	3	9	14	15	42.32"
Oakridge Sal. H.	17	10	11	7	7	4	1	1	3	8	14	15	45.77"
Qtzville	16	12	12	7	6	4	1	1	3	9	12	17	91.44"
Santiam Jct.	14	12	13	8	6	4	1	2	3	7	15	15	70.97"
Santiam Pass	22	7	11	7	4	3	1	2	4	7	14	18	88.87"
West Fir	14	12	11	8	7	4	1	1	4	9	14	15	48.55"
Forest Average	16	11	11	7	6	4	1	1	3	9	14	16	

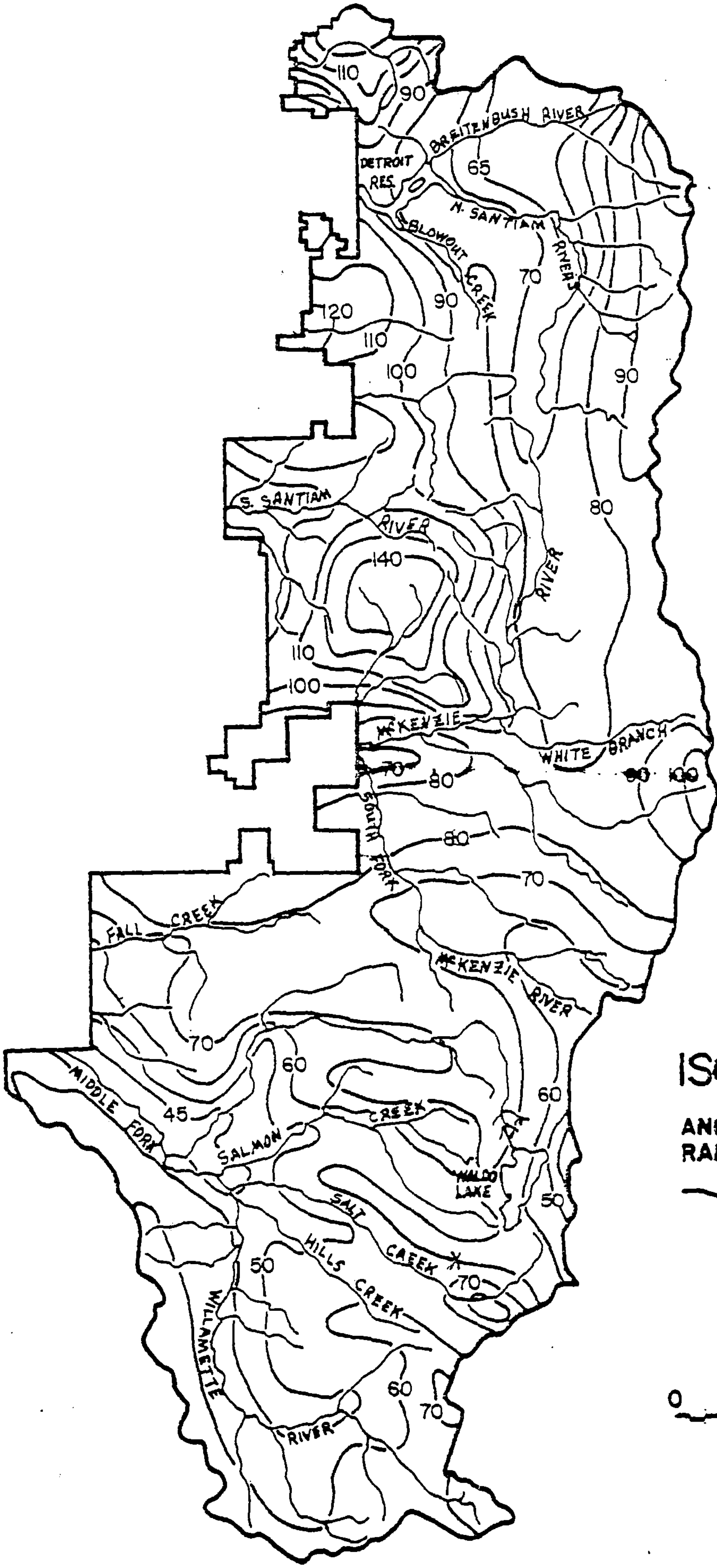


FIGURE 6

ISOHYETAL MAP

ANNUAL AVERAGE RAINFALL IN INCHES

—70—

0 5 10 20

Example 1. Compute average monthly precipitation at:

LOCATION of proposed planting site - Cupit Mary, Upper Salt Creek

ELEVATION - 6,000'

ANNUAL PRECIPITATION - 60" (From ISOHYETAL MAP, FIGURE 6, page 12.)

	J	F	M	A	M	J	J	A	S	O	N	D
Forest Average Percent PPt by Month	16	11	11	7	6	4	1	1	3	9	14	16 1/
Computed Average Monthly PPt in Inches	9.6	6.6	6.6	4.2	3.6	2.4	0.6	0.6	1.8	5.4	8.4	9.6 2/
YEAR'S TOTAL	59.4											

1/ Forest Averages from FIGURE 5, page 11.

2/ Because of rounding errors, totals will vary by one percent (1%).

and the average monthly temperature is determined between the two recording stations.

The change in temperature per 100 feet is then determined, and the average monthly temperature for the selected site is calculated by adjusting the average monthly temperature for either recording station according to the difference in elevation between the selected site and either station. This is tedious because it must be done twelve times for each site. (Example 2, page 15.)

Now that it has been explained how to make the climatic calculations by hand for a specific site, it should be pointed out that a simple computer program has been developed on the Willamette that does all the work automatically. This program is called "SRI.CIPTEM." (See FIGURE 7, page 16.)

All that is required is that the operator enter (1) the estimated average annual precipitation for a specific site, and (2) the location number of two selected climatic stations. The computer does the rest and prints out the average monthly precipitation and the average monthly temperature for the selected site. This computer program contains climatic information only for the Willamette National Forest, however, and cannot be used for other areas.

Example 2. Compute average monthly temperature at Cupit Mary 14 timber sale, elevation 6,000 feet.

SOLUTION:

A = Oakridge Salmon Hatchery elevation and average monthly temp.

B = Santiam Pass elevation and average monthly temp.

C = Difference in elevation between A and B.

D = Difference in average monthly temperatures between A and B.

E = Monthly temperature change per 100 feet $= \frac{D \times 100'}{C}$

F = Elevation of site for which average monthly temperatures are being computed.

G = Monthly temperature correction = F - Elev. B x E/100'

H = Monthly temperature at F - Monthly Temp. @ B - G

			Average Monthly Temperature											
Step	Climate Station	Elev.	J	F	M	A	M	J	J	A	S	O	N	D
A	Oakridge Salmon Hatchery	1,275'	37.5	42.4	45.4	49.9	55.8	61.6	67.2	67.2	62.1	53.5	44.9	39.1
B	Santiam Pass	4,748'	27.4	30.4	32.0	34.5	43.3	51.2	58.4	58.0	50.5	41.8	34.2	28.1
C	DIFFERENCE	3,473'												
D		-	10.1	12.0	13.4	15.4	12.5	10.4	8.8	9.2	11.6	11.7	10.7	11.0
E			0.29	0.34	0.38	0.44	0.36	0.30	0.25	0.26	0.33	0.34	0.31	0.32
F	Cupit Mary 14	6,000'												
G			3.63	4.25	4.88	5.50	4.50	3.76	3.13	3.25	4.13	4.25	3.88	4.01
H	Average Monthly Temperature at Cupit Mary 14, 6,000' Elevation		23.8	26.1	27.2	28.9	38.8	47.5	55.2	54.7	46.3	37.6	30.3	24.1

FIGURE 7. Sample S.R.I. CIPTEM program illustrating the CUPIT MARY 14 planting site at 6,000 feet elevation and 60 inches precipitation.

```
*UNIVAC 1100 OPERATING SYSTEM VER. 31-244-23V  (RSI)*
@RUN
DATE: 021876        TIME: 105801
>@ASG,A SRI
READY
>@ADD SRI.CIPTEM
READY
FACILITY WARNING  100000000000
CASE UPPER ASSUMED
ED 14.02-02/18-10:59-(,0)
INPUT
EDIT
EOF FOUND
LINES:15 FIELDATA
READY
 ENTER NAME OF CLIMATE STATION(14 SPACES MAX.)
>CUPIT MARY 14
 ENTER PRECIP. IN INCHES(2 PLACE INTEGER)
>60
 ENTER A,B,C(SEPARATED BY COMMAS)
   WHERE,
    A=CLIM. STAT. ELEV.(INTEGER NO.)
    B=A SRI STAT. NO.
    C=ANOTHER SRI STAT. NO.
>6000,13,14

 CUPIT MARY 14  COMPUTED MONTHLY PRECIP. & TEMP. VALUES

   MONTHLY PRECIPITATION
    9.6, 6.6, 6.6, 4.2, 3.6, 2.4,  .6,  .6, 1.2, 5.4, 8.4, 9.6
   CLIMATE STATION ELEVATION = 6000
   MONTHLY TEMPERATURE
   23.8,26.1,27.2,28.9,38.8,47.5,55.2,54.7,46.3,37.6,30.3,24.1

 IF END, ENTER 0          IF TRY AGAIN, ENTER 1
>0
>@FIN
```

SOIL SAMPLES

At least five weeks in advance of the anticipated start of planting, soil samples should be collected from units where soil moisture is suspected of being a limiting factor. Soil samples should also be collected from units scheduled for late spring and early fall plantings. The soil samples should be taken at the eight-inch (8") depth and should consist of two undisturbed cores, and one disturbed sample weighing one pound. The samples are then sent to the Oregon State University Soils Laboratory for the following analysis:

1. Bulk density.

2. Moisture determinations at:

   a. 0.1 atmosphere

   b. 1/3 atmosphere

   c. 0.8 atmosphere

   d. 1.0 atmosphere

   e. 5.0 atmosphere

   f. 15.0 atmosphere

From the above data, a soil moisture curve of percent by volume is constructed for each different soil. (See FIGURE 8, page 19.) This curve will be used in conjunction with a soil tensiometer for determining "inches of water."

Site-Specific Data Required for "REGIME" Computer Run

1. Average monthly precipitation from computer program " SRI.CIPTEM."

2. Average monthly temperature from computer program "SRI.CIPTEM."

3. Elevation from topographic map.

4. Location of area for which you are computing data, sale name, and unit number.

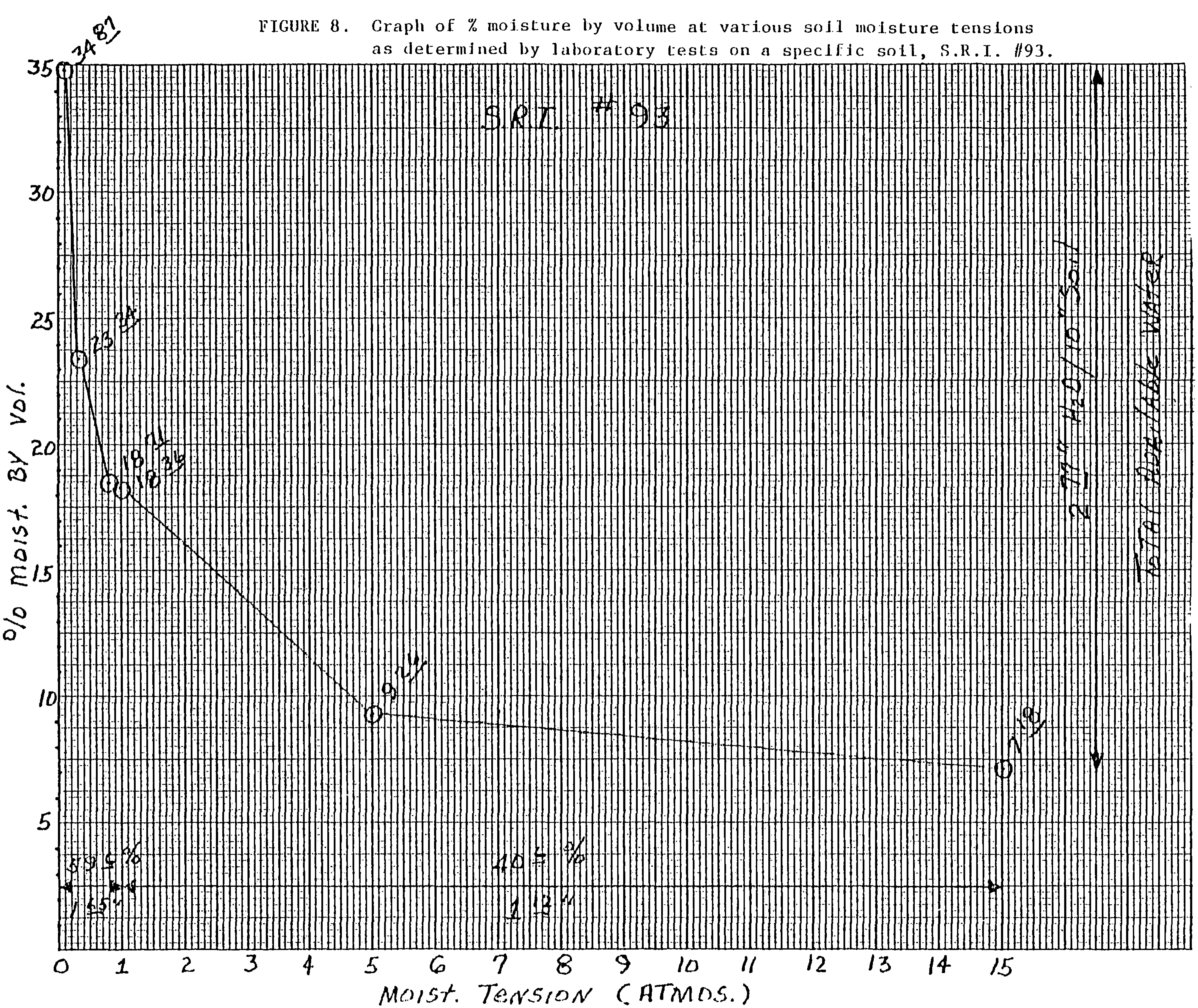
5. Latitude in degrees and minutes from topographic map.

6. Slope and aspect in percent and degrees from field records, topographic maps, etc.

7. Soil SRI number from SRI map and/or field examination.

8. Percent by volume of rock in soil greater than 2mm. in diameter as determined in the field.

FIGURE 8. Graph of % moisture by volume at various soil moisture tensions as determined by laboratory tests on a specific soil, S.R.I. #93.



9. Field capacity of soil. Percent by volume from lab test results.

10. Wilting point of soil. Percent by volume from lab test results.

11. Graph of soil moisture tension curve. Drawn from lab test results. (See FIGURE 8, page 19.)

With the exception of items 8. through 11., all of the above items can be readily determined in the office from existing information. Item 8 is an on-site determination. Items 9, 10 and 11 are based on lab test results but can be estimated by the Forest Soil Scientist.

When all of the above information is assembled, the "REGIME" computer program can be run. REGIME is a completely conversational program used on a low-speed remote terminal tied into the Fort Collins Computer Center. The program can be used with a minimal amount of training, and the user does not need to have a knowledge of computer science. All that is required is that the operator correctly enter the proper information when called for. The computer will automatically make all calculations and printouts.

USE OF COMPUTER INFORMATION

1. From the REGIME computer printout table, construct a graph on yearly graph paper of:

   a. Monthly precipitation - BLUE line

   b. Monthly potential evapo-transpiration - YELLOW line

   c. Monthly soil moisture - RED line

   d. Wilting point - RED DASHED line

   This graph shows changes in soil moisture status, based on past climatic records for a specific site and soil. (See FIGURE 3, page 7.)

2. Calculate daily loss of water for each month due to potential evapo-transpiration and show on graph. (See FIGURE 3, page 7.)

3. Make field moisture measurements (8" depth) using a soil tensiometer. Remember that 100 on the dial of the probe is equal to 1 "atmosphere" or "bar" on the soil moisture chart.

4. Use tensiometer dial readings to determine percent moisture by volume from soil moisture chart. (See FIGURE 8, page 19.)

5. Multiply percent moisture by volume by 10 inches to determine inches of water. Be sure to make allowance for the volume in the soil occupied by coarse fragments larger than 2mm.

6. Enter inches of water on computer printout graph on the date that measurements were taken.

7. Determine if four weeks of soil water are available for plant growth. If not, can precipitation be expected to make up the difference?

CONCLUSION

This program has been in use on the Willamette National Forest for two years. Upcoming stocking surveys should show what effect this program is having on difficult sites where soil moisture has been limiting. One specific conclusion has been determined. Field moisture measurements using the tensiometer have greatly increased the user-awareness level of changing field soil moisture conditions during the planting season, and has allowed later spring plantings and earlier fall plantings than has been previously thought possible.

The use of this program in the future should greatly reduce the risk of planting under adverse soil moisture conditions and should improve the likelihood that optimum soil moisture conditions will occur during and after planting.